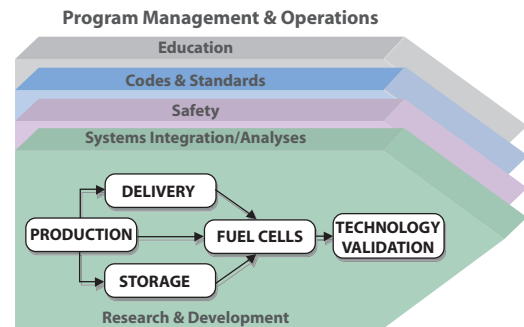


6.0 Program Management and Operations

The DOE Hydrogen Program is comprised of activities within the Offices of Energy Efficiency and Renewable Energy (EERE); Fossil Energy (FE); Nuclear Energy, Science and Technology (NE); and Science (SC). EERE's Hydrogen, Fuel Cells & Infrastructure Technologies Program represents a major component of this effort. Each office manages those activities within its mission area, but because of the complexity involved in transitioning to a hydrogen-based economy, the DOE Hydrogen Program is being managed through a single Program Manager located within EERE. This allows for clear lines of communication and authority, and integrates the many participating offices, agencies, laboratories, and contractors.



DOE's Hydrogen Program includes RD&D, systems integration, safety, codes and standards, and education activities, requiring the integrated efforts of Washington, D.C. offices, field offices, laboratories, and contractors spread across the country. Thousands of individuals will take part in the Program through partnerships with automotive and power equipment manufacturers, energy and chemical companies, electric and natural gas utilities, building designers, diverse component suppliers, other federal agencies, state government agencies, universities, national laboratories, and other stakeholder organizations. This complexity requires a Program management and operations approach based on a uniform set of requirements, assumptions, expectations, and procedures.

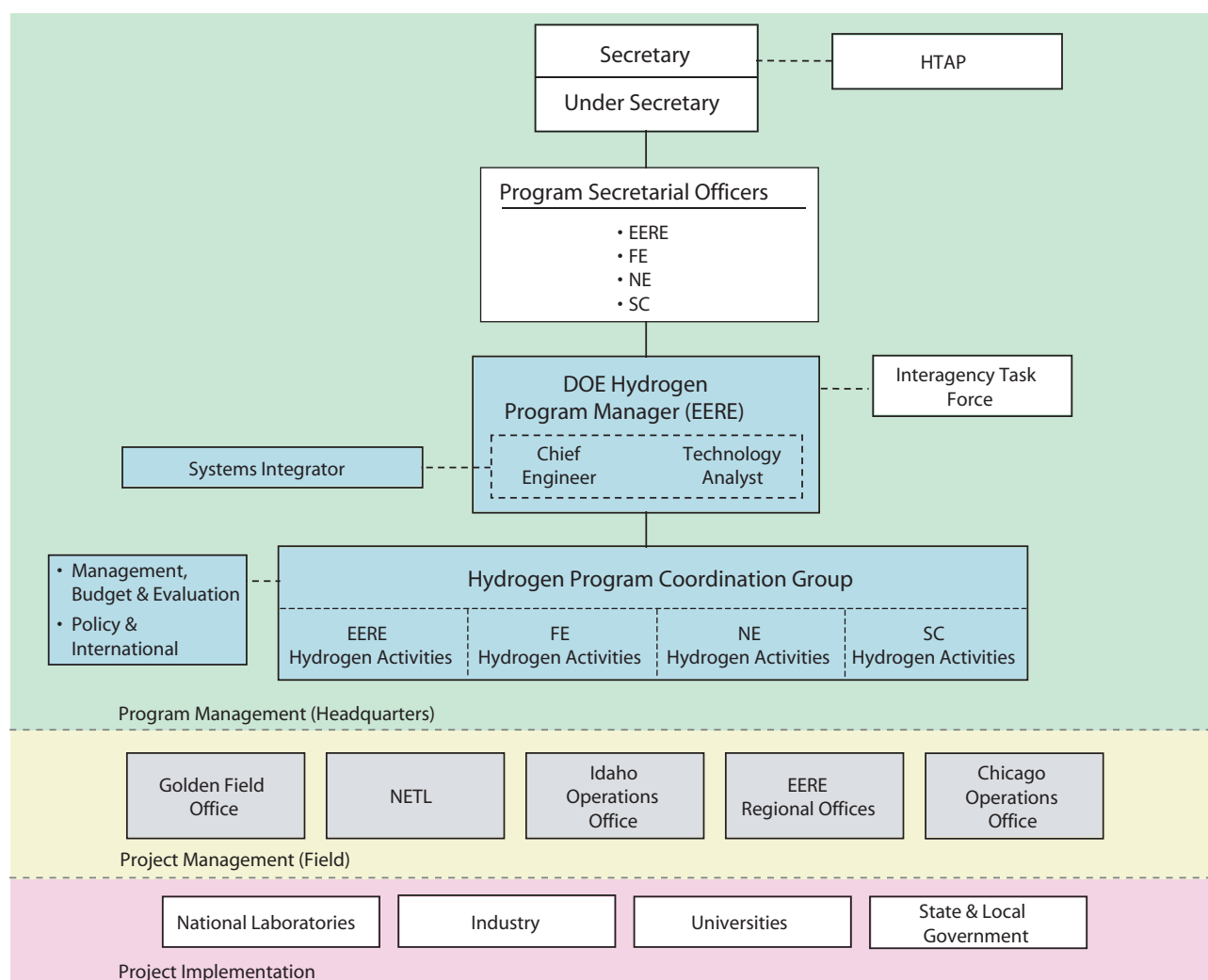
6.1 Program Organization

The organizational structure of the DOE Hydrogen Program is shown in Figure 6.1.1. Program management takes place at DOE Headquarters in Washington, D.C. Project management is conducted in field locations, namely the Golden Field Office, EERE Regional Offices, the National Energy Technology Laboratory (NETL), Idaho Operations Office, and the Chicago Operations Office. Project implementation is carried out at the national laboratories, with industry and universities, and through coalitions with state and local government agencies.

The management approach is grounded in the following results-oriented management principles:

- A vertical organization with clear lines of responsibility and authority
- Top-down Program (to project) planning from conception to technology validation, and time-phased technical, cost and schedule baselines
- Centralization of key functions to ensure effective integration of the Program's projects
- Independent Program control systems ensuring maximum visibility/transparency

Figure 6.1.1. DOE Hydrogen Program Organization Chart



Advisory Groups

The DOE Hydrogen Program utilizes outside experts to advise management on all aspects of the transition to the hydrogen economy. The Program draws upon the best available information from experts in a variety of fields such as chemistry and chemical engineering, materials science, environmental sciences, biology, physics, mechanical engineering, and systems engineering. Since the creation of the DOE Hydrogen Program, a variety of groups have been identified or created to oversee, review, or advise Program activities. Two examples of DOE Hydrogen Program advisory groups include:

National Academies. At DOE's request, the National Academies' National Research Council and the National Academy of Engineering appointed a committee in September 2002 to conduct a study of Alternatives and Strategies for Future Hydrogen Production and Use. The study evaluated the cost and status of technologies for production, delivery, storage and end-use of hydrogen, and reviewed DOE's hydrogen research, development and demonstration strategy. The final report is available at <http://books.nap.edu/books/0309091632/html/index.html>. In addition, the National Academies have been asked by DOE to do periodic assessments of the Program.

Hydrogen Technical Advisory Panel (HTAP). Legislation called for the establishment of HTAP to advise the Secretary of Energy on DOE's Hydrogen Program activities. HTAP is comprised of between 12 and 25 members. The Secretary appoints members to represent domestic industry, academia, professional societies, government agencies, and financial, environmental, and other appropriate organizations to provide the range of technical expertise and other experience required.

HTAP reviews and makes recommendations to the Secretary in a biennial report on:

- The implementation and conduct of programs and activities
- The safety, economical, environmental and other consequences of technologies for the production, distribution, delivery, storage and use of hydrogen
- Means for resolving barriers to implementing hydrogen and fuel cell technologies

The Secretary considers, but is not required to adopt, any recommendations of HTAP. The Secretary either describes the implementation of each recommendation made in the biennial report, or provides an explanation to Congress of the reasons that a recommendation is not to be implemented. The Secretary also provides the resources necessary for HTAP to carry out its responsibilities.

Public-Private Partnerships

Through cooperative partnerships, the DOE Hydrogen Program is leveraging the vast capabilities and experience of stakeholders in industry, state and local governments, and international organizations. The roles of these groups vary, as does the nature of their collaboration with DOE. In broad terms, the roles that these stakeholder groups play are:

- **State and Local Governments.** Partnerships in codes and standards, field validation and education
- **Industry.** Partnerships in developing, validating and demonstrating advanced fuel cell and hydrogen energy technologies
- **International.** Partnerships in R&D, validation, codes and standards and safety

State and Local Governments. The California Fuel Cell Partnership is a unique collaboration of auto manufacturers, energy companies, fuel cell technology companies and government agencies that is placing fuel cell vehicles on the roads in California. This partnership is showcasing new vehicle technology that could move the world toward practical and affordable environmental solutions. The other government partners include the California Air Resources Board, the California Energy Commission, the South Coast Air Quality Management District, DOT and EPA.

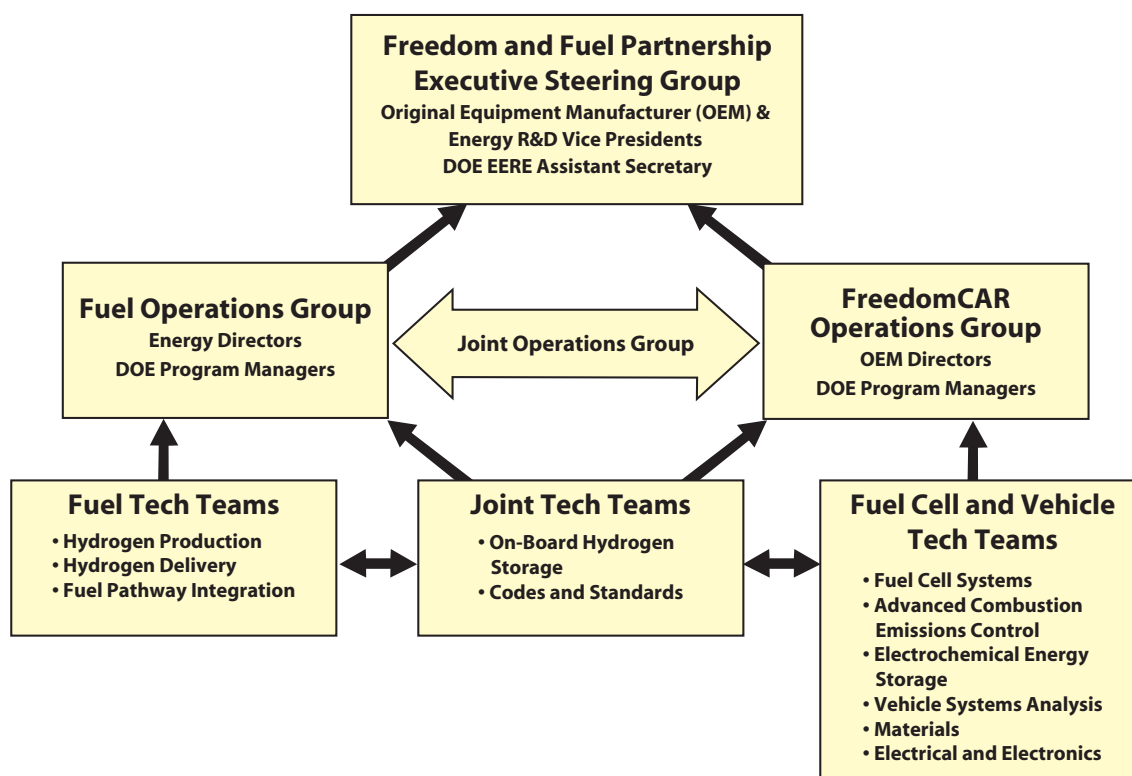
The state and local partnerships that take place through the Regional Offices are the primary vehicle through which DOE meets the needs of individual citizens, cities, counties and states across the nation. The Program will coordinate with the Regional Offices to:

- Work with states and communities to promote the Program
- Identify and engage community and state partners
- Integrate the Program with public and private sector activities

Industry. The FreedomCAR and Fuel Partnership includes the Department of Energy, USCAR and five energy companies to develop the technologies and the infrastructure for hydrogen fuel cell vehicles to emerge in the transportation sector. The Executive Steering Group (ESG) provides governance and management of the Partnership (see Figure 6.1.2). The ESG is comprised of the DOE Assistant Secretary for EERE and a senior executive responsible for R&D from each of the partnership member companies.

The Operations Groups are responsible for operations oversight of partnership activities and serve as primary information channels to the ESG. Both operations groups include the DOE Program Managers for the Hydrogen, Fuel Cells & Infrastructure Technologies Program and the FreedomCAR and Vehicle Technologies Program. The FreedomCAR Operations Group also includes the senior technical managers from the automotive companies, while the Fuel Operations Group includes senior level technical directors from energy companies. The operations groups are responsible for identifying and managing their respective technical teams.

Figure 6.1.2. FreedomCAR and Fuel Partnership Executive Steering Group



The technical teams consist of scientists and engineers with technology-specific expertise from the automotive and energy partner companies, DOE, the national laboratories, and other sources on an as-needed basis such as the supplier community and other government agencies. The primary purpose of the technical teams is to identify and recommend comprehensive technical goals and evaluate progress and the achievement of technical milestones. Each of the partners will consider the information developed by the technical teams in implementing its respective R&D programs.

Coordination

Interagency Task Force. The Hydrogen Research and Development (R&D) Interagency Task Force was established shortly after the President's announcement of the Hydrogen Fuel Initiative in early 2003. It serves as the key mechanism for collaboration among the eight federal agencies that fund hydrogen-related research and development. The task force has developed an extensive hydrogen research taxonomy of past, present and potential future hydrogen activities of the federal government; provided guidance for agency research directions; identified key areas for interagency collaboration; and established subgroups to develop and implement a 10-year Interagency Coordination Plan. The subgroups coordinate focused efforts in three areas:

- Fundamental Research (led by DOE’s Office of Science)
- Hydrogen Production, Distribution and Storage Technologies (led by DOE’s Office of Energy Efficiency and Renewable Energy)
- Hydrogen Conversion Technologies (led by the U.S. Department of Commerce’s National Institute of Standards and Technology).

The task force is co-chaired by the White House Office of Science and Technology Policy (OSTP) and the Department of Energy (DOE), and includes the Department of Transportation; Department of Defense; Department of Agriculture; Department of Commerce; Environmental Protection Agency; National Aeronautics and Space Administration; National Science Foundation; and, from the Executive Office of the President, OSTP, Office of Management and Budget, and Council on Environmental Quality.

International. On April 23, 2003, Secretary Abraham called for an “International Partnership for the Hydrogen Economy.” As a result of the Secretary’s vision, efforts have been initiated with 15 countries and the European Commission in the areas of codes and standards, PEM fuel cells, hydrogen production, hydrogen storage, and economic modeling.

The Secretary’s call for an international partnership builds on the efforts of the last several years in which DOE has coordinated international activities to advance hydrogen and fuel cell technologies. DOE is taking a leadership role in the International Energy Agency Hydrogen Implementing Agreement and Advanced Fuel Cell Implementing Agreement (see Table 6.1.1).

Table 6.1.1. International Energy Agency Hydrogen and Advanced Fuel Cell Implementing Agreement Tasks

Hydrogen	Fuel Cells
<ul style="list-style-type: none"> • Photobiological Production • Hydrogen from Carbon-Containing Materials • Solid and Liquid State Storage • Integrated Systems Evaluation • Hydrogen Safety • Water Photolysis 	<ul style="list-style-type: none"> • Polymer Electrolyte Fuel Cells • MCFC Towards Demonstration • Solid Oxide Fuel Cells • Fuel Cells for Stationary Applications • Fuel Cell Systems for Transportation • Fuel Cells for Portable Applications

In addition, the Program is working with international groups, such as the ICC and the ISO to develop a comprehensive set of codes and standards, which will facilitate the global demonstration and commercialization of hydrogen and fuel cell technologies.

6.2 Program Management Approach

The overall management of the DOE Hydrogen Program consists of a performance-based planning, budgeting, execution, and evaluation system as shown in Figure 6.2.1.

Figure 6.2.1. The Four Phases of Program Management



Program Planning

The National Energy Policy and the President’s Hydrogen Fuel Initiative provide the planning foundation for the DOE Hydrogen Program. The Program integrates the hydrogen planning in EERE, SC, FE, and NE. Each year, these offices will collaborate to integrate each office’s fiscal year planning and budgeting into the DOE Hydrogen Posture Plan, which will reflect the prior year’s appropriations and the budget requested of Congress in the upcoming fiscal year. Individual office research plans supporting the Posture Plan will be provided to the DOE Hydrogen Program Manager for concurrence to ensure consistency in planning.

Program Budgeting

The budget for DOE’s Hydrogen Program falls under the jurisdiction of two separate Congressional appropriations subcommittees. The key activities by DOE office are shown in Table 6.2.2.

Budget Execution

Table 6.2.2. DOE Hydrogen Program Key Activities by Budget Appropriation

Energy and Water Development	Interior and Related Agencies
<ul style="list-style-type: none"> • EERE <ul style="list-style-type: none"> – Hydrogen Technology <ul style="list-style-type: none"> ○ Hydrogen Production and Delivery ○ Hydrogen Storage ○ Hydrogen Infrastructure Validation** ○ Safety, Codes and Standards ○ Systems Analysis and Education • Office of Nuclear Energy, Science and Technology <ul style="list-style-type: none"> – Generation IV Nuclear Systems Initiative* – Nuclear Hydrogen Initiative • Office of Science <ul style="list-style-type: none"> – Chemical Science, Geoscience, and Energy Science – Materials Science and Engineering 	<ul style="list-style-type: none"> • EERE <ul style="list-style-type: none"> – Fuel Cell Technology <ul style="list-style-type: none"> – Transportation Systems – Distributed Generation Systems – Fuel Processing – Stack Components – Technology Validation** – Technical/Program Support • Office of Fossil Energy <ul style="list-style-type: none"> – Fuels, Hydrogen from Coal – Carbon Sequestration* – Pipeline Infrastructure*

* The appropriations indicated by an asterisk support the President’s Hydrogen Initiative, but are not directly a part of it, and would be funded even without it.

** Resources appropriated in Infrastructure Validation under the Hydrogen Technology subprogram and Technology Validation under the Fuel Cell Technology subprogram are planned, executed and evaluated as one project.

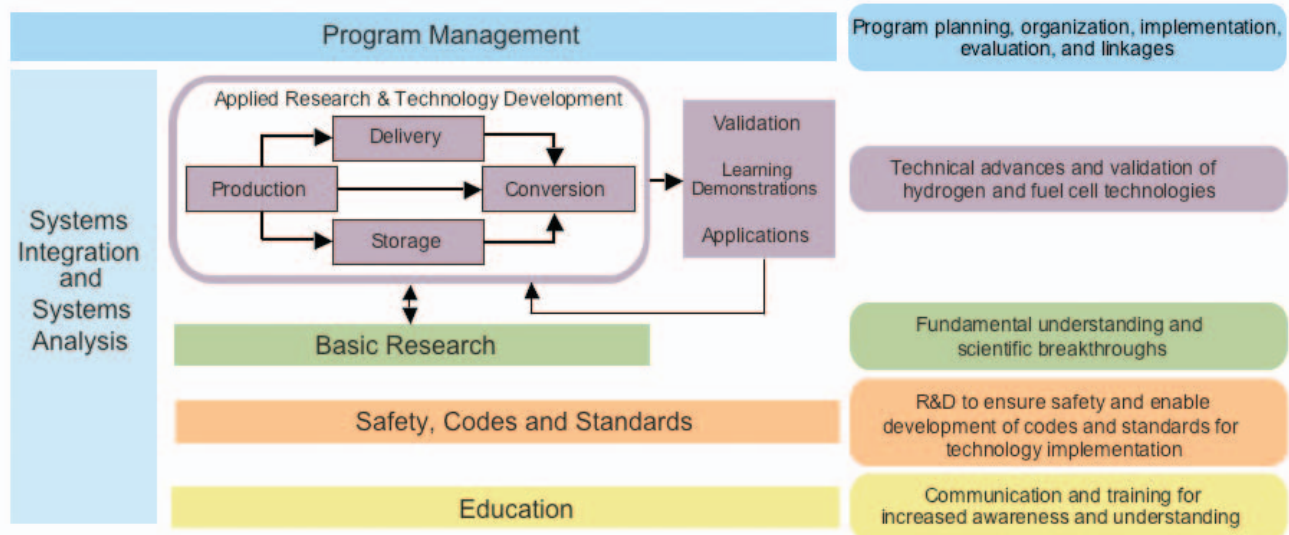
Analysis and Evaluation

Program budget performance is regularly evaluated by OMB, in consultation with the Office of Science and Technology Policy. The OMB evaluation includes both the OMB R&D Investment Criteria and the OMB Program Assessment Rating Tool (PART) process. The criteria are used to guide Program budget planning, management review, and performance goals and targets. Each year, the Program reports the current status against pre-established Program goals. In addition, projects are evaluated through the Program's Annual Merit Review and Peer Evaluation, and through FreedomCar and Fuel Partnership Tech Team review.

6.3 Program Elements

Achieving the hydrogen economy will require successfully addressing technical RD&D challenges including lowering the cost of hydrogen production, delivery, storage, conversion (e.g., fuel cells), and end-use applications; establishing effective codes and equipment standards to address safety issues; and instituting outreach and education campaigns to raise awareness, accelerate technology transfer, and increase public understanding of hydrogen energy systems. To ensure the success of the hydrogen economy, DOE's Hydrogen Program has identified the Program elements that are shown in Figure 6.3.1. The complex interdependencies of these elements and technology options need to be understood and their interfaces managed to achieve overall Program objectives. Consequently, as research provides new insights and as markets and policies evolve, the Program will continuously reexamine its understanding of hydrogen system developments and refine Program elements accordingly (the role of the Systems Integration function). To provide this research feedback loop effectively, it is essential that a continuum of basic and applied research, technology development, and learning demonstrations constitute the Program's portfolio.

Figure 6.3.1. DOE's Hydrogen Program Elements



6.4 Program Implementation

The implementation strategy for the DOE Hydrogen Program has three functions:

- **Linking the RD&D and Education Efforts to Policies, Requirements, and the Process for Selecting Options.** The development of an implementation strategy ensures that activities and procedures are consistent with the rationale and analysis underlying the Program.
- **Organizing the Program.** The implementation strategy includes an organizational structure, procedures, budget and schedule for carrying out the Program, and ensures the clear assignment of responsibility and accountability.
- **Managing and Monitoring the Program.** The implementation strategy includes monitoring the Program so that technological, cost, and scheduling issues can be addressed when they arise.

To carry out these functions, the DOE Hydrogen Program implementation strategy consists of the following components:

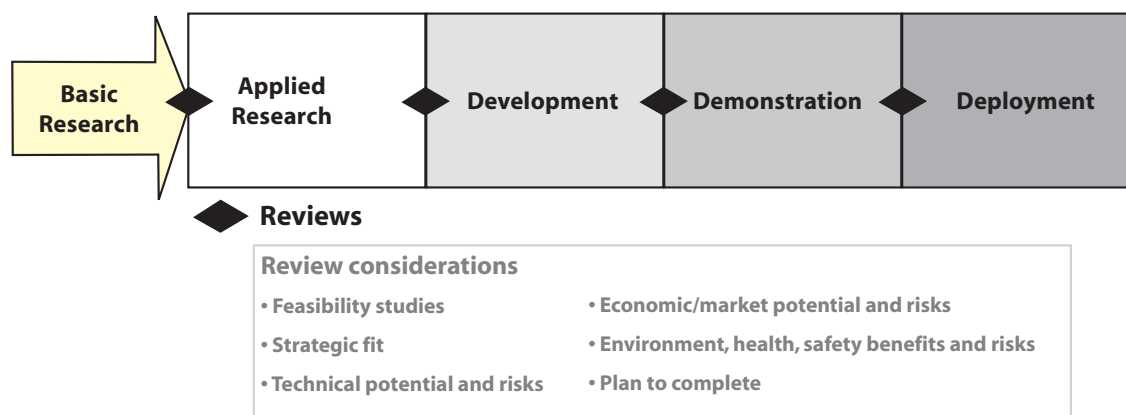
- Program Management Approach
- Organization Plan
- Acquisition Strategy
- Technical Management Strategy
- Safety, Quality Assurance, Environmental Compliance and Security Strategies
- Program Schedule, Cost and Staffing Plan

6.5 Decision Making

A systematic decision process based on sound analytics and technical evaluation standards will provide a credible and transparent basis for key Program decisions. A modified Stage-Gate™¹ process will be used to manage investments in development projects. The Stage-Gate™ process (represented conceptually in Figure 6.5.1) is a disciplined approach for evaluating projects at key points (gates). For the DOE Hydrogen Program, this decision framework will account for evolving markets and government policies.

At the beginning of each stage is a gate, or a Go/No-Go decision point, that must be passed before work on the next stage can begin. Reviews held at these key stages ensure that a project has met its objectives and that the plan for proceeding will satisfy the criteria for the next gate. Reviewers may include individuals from the government, national laboratories and the private sector.

Figure 6.5.1. Stage-Gate™ Decision Process



¹ Professor Robert Cooper of McMaster University, Ontario, Canada has written and consulted extensively on this process and has trademarked the term.

The general types of criteria used at each stage are shown in the figure, with the specific criteria becoming more rigorous as the project advances toward commercialization. At each gate, decisions are made to either:

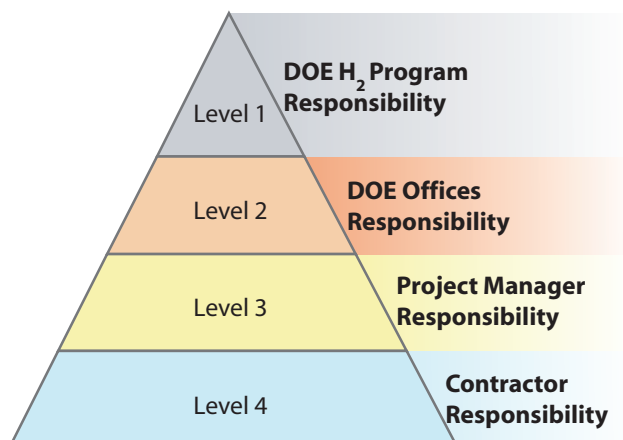
- Advance the project to the next stage
- Continue the current effort because not all goals have been met
- Place the project on hold because the need appears to have gone away, but could re-emerge
- Stop the project because it is unlikely to meet its goals or the need for the effort has permanently disappeared

Each of the gate reviews is conducted in the context of changing external conditions, with consideration of new knowledge and insights that are gained within the Program, and with a focus on the impact of decisions on overall Program outcomes.

6.6 Program Schedule

The schedules and milestones supporting the DOE Hydrogen Program are divided into a multi-tier hierarchical structure consisting of the Program master schedule, Program summary schedules, project intermediate schedules, and project detailed schedules. This structure, shown in Figure 6.6.1, provides the framework for vertical and horizontal integration among organizations, participants, and technologies.

Figure 6.6.1. DOE Hydrogen Program Schedule Hierarchy



At this time, all of the schedules and milestones are based on available cost estimates and projected budget appropriations. Because most of the first phase of the Program (through 2015) focuses on RD&D, it is not currently known which technologies will be winners or losers, and therefore schedules and budgets will be continually adjusting to accommodate the results of Program activities.

6.7 Program Control

To ensure that the DOE Hydrogen Program remains on schedule and within cost, a Program control system is being instituted with the following objectives:

- Provide assurance that all work has been planned and considered in developing the Program cost and schedule baselines
- Identify the necessary procedures and organizational measures required for effective, timely management of the effort
- Ensure that these measures are implemented and that the resulting information accurately reflects the status of the Program
- Establish a review and decision-making process that addresses Program dynamics

Under the Program control system, integrated cost, schedule, and supporting baselines are developed. The performance of the DOE Hydrogen Program offices and supporting organizations (contractors, national laboratories, etc.) in completing tasks is measured against these baselines and reported to their organizations, so that action can be taken if baselines and actual performance diverge significantly.

Responsibilities for Program Control Implementation. The Chief Engineer is responsible for Program control. The Systems Integrator—in support of the Chief Engineer—gathers, integrates, and analyzes information on the scope, schedule, and budget of elements. Element plans and schedules are integrated into a Program plan, work breakdown structure, and master schedule. Together these plans comprise the programmatic baseline that is associated with a specific version of the technical baseline. The Systems Integrator analyzes this information to ensure that all technical requirements are addressed and consistent, and to identify critical-paths, milestones, and decision points. The Systems Integrator provides tools and information to support DOE in monitoring performance against schedule and budget and in identifying risk.

Implementation of Program Control. Figure 6.7.1 provides an overview of the DOE Hydrogen Program's Program control process. The primary inputs to Program control include the integrated baseline (see Section 5), budget guidance, and results of prior Program reviews.

Figure 6.7.1. Program Control Process

